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THE GEOGRAPHIC AFFINITIES OF THE VASCULAR FLORAS OF NEW ENGLAND, THE MARITIME PROVINCES AND NEWFOUNDLAND¹

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The region assigned me for discussion, the area east of the Hudson, Champlain and Richelieu Valleys and south of the St. Lawrence and the Straits of Belle Isle, including the political areas of New England, southeastern Quebec, the Maritime Provinces and Newfoundland, has long been recognized by the geologist and the physiographer as essentially an orographic unit. Exhibiting the highest degree of complexity in its geological history and structure, as contrasted with the essentially uniform structure of vast areas in the interior of the continent, the region may be defined as the northeastern extension of the Appalachian system, bordered on the extreme south, about the southwestern shores of the Gulf of St. Lawrence, and inland along the principal valleys by level plains which were largely occupied by the Champlain sea at the close of the Pleistocene. In fact, so generally was the region affected by the Wisconsin glaciation and the Champlain subsidence, that only a few very isolated localities seem to have escaped the general extermination of the flora which had formerly occupied the land. We have consequently to deal in this region with a flora which has migrated to its present position since the close of the Pleistocene glaciation. The attempts to account for these migrations and to trace with approximate accuracy the geographical history and wanderings of the various components of the complex which we now call the indigenous flora of the region are fascinating and vastly important problems, but without a thoroughly accurate knowledge of the

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flora as it now exists all such explanations and attempts at correlation are futile; and, although I have been allowed the maximum time to present my case, I must emphasize at the start the impossibility of presenting in one hour more than the briefest suggestion of the problem, leaving until we better understand our flora the consideration of its exact geographic origin.

This limited region, from the Hudson and Champlain Valleys to the Straits of Belle Isle, contains only about 200,000 square miles of land and fresh water, far less than the state of Texas, and approximately the area of the combined states of Colorado and Wyoming. In latitude the region lies chiefly between the 41st and 50th degrees—or parallel with the region from southern Iowa to Lake Winnipeg or from Humboldt County, California, to southern British Columbia. Among the earliest districts in America to be settled by Europeans and the seat of many of our ancient institutions of learning, the region, one might naturally suppose, would ere this have had its flora thoroughly worked out. In fact more than one botanist resident outside New England and some who have lived within her borders have expressed this belief. Thus we find the printed statement of one who has attempted an exposition of all the phytogeographic areas of the continent, that "no one region in North America has been more carefully studied botanically than New England."

Nevertheless, during the past quarter-century, since active botanical exploration of New England, adjacent Canada and Newfoundland has been prosecuted by the present generation, many hundreds of species have been added to the known flora of the region. And during the last decade it has been a poor summer indeed which has not yielded to light a score of novelties, while exceptional seasons have yielded a full hundred additions to the known vascular flora of the area. Certain days stand out vividly in my mind, when the additions to the flora for the single day have mounted to fifteen and sometimes even to twenty-five species.

The majority of plants of the greatest phytogeographic interest are, naturally, species of highly specialized requirements and consequently somewhat localized in a region. They are not to be seen from the stage-coach, steamboat or railroad-train but must be sought in their exclusive haunts. It is for this reason that many easy-going botanists have entirely missed the truly significant plants of regions they have glimpsed from the steamboat or train. For instance, when

the American Association met at Montreal in 1882, an excursion was made down the St. Lawrence and up the Saguenay. In writing of this excursion through one of Nature's botanic gardens, an active botanist of that time said: "Probably the prevailing feeling among botanists at Montreal, from 'The States,' was one of surprise and disappointment that the Canadian flora was so familiar. At Montreal I noticed nothing of interest either among the weeds or the wild flowers. At Quebec, *Euphrasia officinalis* was abundant on the ramparts. At Tadousac, *Empetrum nigrum* and *Vaccinium Vitis-Idaea* were growing at sea-level, the latter so abundant that children were bringing in pails of the berries for sale.

"At Ha! Ha! Bay, where I had intended stopping if the flora seemed attractive, the only unfamiliar plant was *Senecio vulgaris* as an abundant weed.

"The meeting next year at Minneapolis will doubtless offer many more botanical attractions to eastern botanists."

Now, to one who has tramped the shores and clambered with the aid of an alpine rope over many cliffs of the lower St. Lawrence it is apparent that the writer of the passage above quoted was merely the prototype of that later group of botanists whose depth of interest in the problems of phytogeography finds expression in the statement that "it would be quite possible to prepare a fairly satisfactory description of the vegetation of a given region without naming a single species." From this superficial and uncommunicative point of view the traveller down the St. Lawrence might recognize and, if in a communicative mood, perhaps even enumerate such trees as *Abies balsamea*, *Picea canadensis*, or *Acer rubrum* and make a sort of guess as to which mountain ash, white birch, or poplar lined the shores, and he would be reasonably safe in identifying *Heracleum lanatum* and *Sambucus racemosa*; but not one of these wide-spread and almost ubiquitous plants would give him the faintest indication of the botanical interest of the region. If, however, he overcame the inertia of travel sufficiently to walk three minutes from the wharf at Rivière du Loup, the last stop of the steamer before crossing to the Saguenay, he would discover *Cornus suecica*, an arctic species here reaching one of its southernmost outposts in America, *Osmorhiza divaricata* of southern British Columbia, Washington and Oregon, *Arabis Drummondii*, var. *connexa* of the Rocky Mountains, *Poa eminens* of Alaska and adjacent Asia, and scores of other species whose presence here at once suggests the most far-reaching phytogeographic problems.

The localization of plants in the region and the impossibility of recognizing the most significant of them from the steamboat, stage-coach or railroad-train, is further emphasized by a statement of that prince of New England explorers, William Oakes, whose experience elsewhere should have taught him to be more cautious in his drawing conclusions. Writing to his friend Dr. J. W. Robbins on August 14, 1828, Oakes said: "The greater part of July I have spent 'down East' even as far as Quoddy Head which lieth more eastward than Eastport. I have seen there however but few plants new to N. E. and am convinced that no great accessions to the N. E. Flora, and of absolutely new plants hardly any, are to be expected from the State of Maine." For this reason, apparently, Oakes, who had visited one of the most sterile corners of the state, thereafter avoided the supposedly barren state of Maine, the home of the famous crops of Aroostook potatoes, and thus missed some hundreds of species which there make up an essential element of the New England flora. Even at barren Quoddy Head, where Oakes *did* explore, he failed to detect *Iris setosa*, then known only from Siberia; *Comandra livida* and *Carex norvegica*, Arctic species at that time unknown in New England; and the characteristic little *Euphrasia purpurea*, subsequently discovered and described from Newfoundland.

These illustrations should be sufficient to indicate my point of view, that, although the dominant and more or less ubiquitous species may serve for the major phytogeographic divisions of a continent, they are of little value in the more refined studies of plant distribution; but that it is the relic species now localized in isolated areas which give us clues to the long cycles of plant migrations—marches and countermarches—which have accompanied the different geological epochs since the early Cretaceous; and it is to these relic colonies, both of plants and of animals, that the historical geologist must turn in the reconstruction of ancient lands now quite obliterated or buried beneath the great oceans. And even if we belong to that unimaginative group of botanists who would completely divorce taxonomy from other fields of science, we must at least recognize that the discovery in the indigenous flora of eastern Quebec of plants described from Montana, Alaska, or Siberia, or in Alberta or Denmark of species first detected about the Gulf of St. Lawrence, forces upon us the necessity for caution in characterizing new species. It has been an easy principle of convenience but of very unsound scholarship among

us to assume that a novelty found, let us say, in Alberta, must inevitably be an undescribed species, quite overlooking the fact that the identical species may have been already described from Siberia or from Newfoundland. Sound taxonomic work, therefore, demands a broader and more accurate insight into phytogeographic laws, and it is with the hope that by mutual comparisons we may come to a clearer understanding of the relationships of our complex floras that I look with special satisfaction upon the formation of this new section of the Botanical Society. From this long peroration you will see that I have a double motive in presenting for your consideration some of the more patent facts brought out in studying the geographic affinities of the flora with which I am most familiar.

As I have already said, the area I am sketching consists of approximately 200,000 square miles of land, ranging in character from the most arable farm-lands of the Aroostook, Connecticut and Champlain Valleys to sandy wastes, Hudsonian tundra, subalpine forests, saline marshes, granitic rockfields, limestone barrens and seacliffs, and arid cañons. These and scores of other distinct habitats make up a region in many parts quite unexplored and unmapped, but with a phenomenally extensive indigenous flora. The area covered by Coulter and Nelson's *Rocky Mountain Flora*, from northern Arizona and New Mexico to the Black Hills, Montana and southern Idaho, includes about 480,000 square miles and has, as recognized in that work, an indigenous flora of 2,836 species and geographic varieties. Our northeastern region, with an area of 200,000 square miles, less than half Coulter and Nelson's area, has a known indigenous flora as extensive as theirs, more than 2,800 species and varieties; and of these more than 250 are strictly endemic while an additional 50 overstep the bounds of the region only by occurring on Long Island, the Adirondacks, or in southern Labrador. This endemic or essentially endemic element, making altogether more than 10 percent of the flora, is well illustrated by *Rosa nitida* (fig. 1) of the acid bogs from Newfoundland to eastern Connecticut.

Most conspicuous to the casual observer are, of course, the common trees, shrubs and widely dispersed herbs. These, for the most part, are species of broad and continuous range throughout the Alleghenian, Canadian or Hudsonian districts, and often beyond. Typical illustrations of these common and widespread species are the native red currant, *Ribes triste*, and the balsam fir, *Abies balsamea*, of

broad Hudsonian and Canadian range nearly across the continent. Other more familiar examples, because of more southern range, of these widely dispersed species of nearly continuous distribution over a vast area, are *Clematis virginiana*, extending in abundance from eastern Quebec to Georgia and Lake Winnipeg; and *Eupatorium perfoliatum*, abounding from Prince Edward Island to Florida, Louisiana and the Dakotas. The entrance of these floras into the New England-Maritime Province region in solid phalanx from the extensive regions to the southwest, west, northwest and north presents no problem and this major element of our flora (the common and widespread plants) may be dismissed with this brief mention, although such plants as these are the ones most emphasized by many phytogeographers. Similarly we may pass the more strictly Alleghenian plants, such as *Ilex monticola* (fig. 2), which cling conservatively to the rich wooded slopes of the Alleghenies and in New England are found chiefly on the northern extension of the Alleghenies, the Taconics of western Massachusetts and Connecticut.

Of greater interest are the coastal plain species, because they represent in New England, eastern Canada and Newfoundland a relic of the extensive flora which during the late Tertiary migrated northward along the then highly elevated continental shelf and at the drowning of the shelf were left as relics at isolated points. This isolated remnant of the flora derived from the southern coastal plain is represented by about 200 species north of New Jersey, and nearly every excursion to southwestern Rhode Island, Cape Cod, Plymouth County (Massachusetts), Nantucket, southern Nova Scotia, Cape Breton, eastern New Brunswick, Prince Edward Island, the Magdalen Islands or southeastern Newfoundland, adds to the number of thus isolated species known to us or extends our knowledge of those already recognized.

Some of these range northward only from New Jersey, Delaware or Maryland, such species as *Eriocaulon Parkeri*, isolated in the brackish estuaries of the Potomac, Delaware, Housatonic, Mill River (Conn.), Merrimac, Kennebec and Penobscot; or *Chrysopsis falcata*, the common "yellow aster" of southern New England. Others extend north from Florida, Mississippi or southeastern Texas, such species as *Ilex glabra* or the genus *Bartonia* (fig. 3); while a number, like *Drosera filiformis* (fig. 4), occur in the Northeast as colonies quite isolated from the South. Some, like *Panicum Wrightianum*, were originally de-

scribed from the Antilles; while others, like *Eleocharis interstincta* (fig. 5) or *Erigeron pusillus*, are widely dispersed in tropical and subtropical America, occurring in the Bermudas and tropical Mexico, and by way of the Antilles or of Central America extending to South America.

Swinging northward from the Gulf of Mexico along the Mississippi basin, we come into a flora which is familiar to the New Englander, though rarely known to the botanist of the South Atlantic States. This flora common to the Mississippi basin and southern New England is well illustrated by *Ludvigia polycarpa* (fig. 6), which occurs in sloughs and wet depressions from southwestern Ontario and Ohio to Nebraska, southern Missouri and Tennessee,² and east of the Appalachians occurs in three isolated areas: Cumberland Co., Maine; Middlesex Co., Massachusetts; and Hartford Co., Connecticut. This group of species is further illustrated by *Cyperus Engelmanni*, a plant of less general occurrence in the Great Lake-Mississippi region—from southern Ontario to Minnesota and Missouri—and eastward found only in Seneca Co., New York, and in Middlesex Co., Massachusetts, where it has long been known as a characteristic plant of lake-alluvium.

The plants of the drier prairies and plains of the interior are not so definitely restricted to the interior of the continent as might be supposed. In fact, many lists of characteristic plants of dry prairies have a very familiar appearance to the New Englander—*Sporobolus heterolepis*, *Sorghastrum nutans*, *Andropogon furcatus*, *Muhlenbergia mexicana*, *Aster novae-angliae*, *Heliopsis scabra*, etc. These plants, typical of the drier prairies and plains of the interior, are well illustrated by *Solidago rigida*, which is widely dispersed from the Mississippi Valley westward, in one or another of its variations, to the Rocky Mountains and northward to Peace River, and eastward into Ohio and western New York. East of the Alleghenies the plant is localized, from the District of Columbia to Massachusetts.

Another characteristic element in the western flora which has a greater representation in the extreme East than is generally realized is the flora of subsaline or brackish habitats of the Great Plains and the foothills of the Rocky Mountains; such plants, for instance, as *Erigeron loncophyllus*, a species of saline meadows from the Black

² In the maps the northeastern range may be taken as fairly representing the facts in detail, but the ranges west and south of New England are only approximate, and, owing to lack of detailed reports, cannot be considered final.

Hills and the Saskatchewan Plains to Oregon and California, reappearing in northern Asia, and on Anticosti Island at the mouth of the St. Lawrence. A very similar distribution is shown by the Section *Conyzopsis* of the genus *Aster*, a unique group of annual essentially rayless plants with three species: the widely dispersed *A. angustus* of the Great Plains of western North America, salt plains of southern Siberia and Afghanistan and shores of the lower St. Lawrence; a second species, *A. frondosus*, of alkaline spots from the Rocky Mountains to the Pacific; and a third species, *A. laurentianus*, known only from saline or brackish sands of the Gulf of St. Lawrence. A very similar range is shown by several aquatic plants of which a good illustration is *Potamogeton filiformis*, var. *Macounii* (fig. 7), widely spread from the southwest side of Hudson Bay to Alberta and southern California, but eastward known only from Prince Edward Island and the Magdalen Islands, where it is a highly characteristic plant. In fact, just as recent botanizing on Cape Cod and Nantucket is taking much of the distinctive lustre from the botanical fame of the New Jersey Pinebarrens, so the exploration of the saline sands of the lower St. Lawrence, Prince Edward Island and the Magdalen Islands is gradually adding to our known flora of the Northeast a large proportion of the plants of the wet areas of the Great Plains and saline prairies.

So much, very briefly, for the temperate American affinities of the New England-Maritime Province-Newfoundland flora. Now turning to the boreal affinities, we have, of course, an extensive Hudsonian flora, already mentioned, which extends almost uninterruptedly from the Barren Lands and the Labrador Peninsula to northern New England; but in case of the boreal as with the temperate floras the greatest phytogeographic interest attaches to the species of discontinuous range. The most familiar examples of discontinuous ranges in our arctic-alpine flora are, naturally, the widely dispersed circumpolar types, such as *Saxifraga oppositifolia*, of broad range across Arctic Europe, Asia and America, extending locally southward to favorable alpine or subalpine habitats, in America the limestones of western Newfoundland, Anticosti, Gaspé and the northern Green Mountains in the East, the northern Rocky Mountains in the West; or *Salix reticulata* of similar occurrence in the Arctic, but in America extending southward very locally only to western Newfoundland, James Bay, and southern Alaska. Of much more restricted range in the North are the Greenland-Labrador types, many of which, like

Arenaria groenlandica, extend to the New England mountains and coast. But these, like the circumpolar species, would naturally be expected.

The most surprising feature of our alpine and subalpine flora and one which was hardly realized until recent years is the great number of species which are more typical of the Rocky Mountains, Alaska, or even of the northern Sierra Nevada. In the Gaspé Peninsula of Quebec, for instance, a region with an indigenous flora of 1,200 species, three fourths of the species, 800, are plants which occur also in the northwestern United States, British Columbia or Alaska; while other regions in our area considerably extend the number. It is not surprising, therefore, to find along the smaller streams among the Gaspé mountains such characteristic Cordilleran plants as *Lonicera involu-crata* (fig. 8) or *Osmorhiza obtusa*, or on the limestone gravels such typical species of the Canadian Rocky Mountains as *Dryas Drummondii* (fig. 9) or *Salix vestita*.

A still more northwestern flora is represented by such plants as *Adiantum pedatum*, var. *aleuticum*, which extends from the Sierra Nevada of California very locally eastward into the Rocky Mountains, thence northwestward along the Coast Range to the Aleutian Islands, and on to northern Japan; known in the east only from the serpentine mountains of southeastern Quebec and Newfoundland. An even more distinctively northwestern species is *Vaccinium ovalifolium* of Washington, British Columbia and Alaska, which reappears about Lake Superior, and again on the Gaspé Peninsula of Quebec, in Newfoundland and adjacent Labrador.

The maritime flora also shows a large North Pacific element, such plants as *Arenaria peploides*, var. *maxima*, occurring on the shores of Japan, Kamtchatka and the Aleutian Islands, and again in western Newfoundland; while a strong Bering Sea affinity is shown by the very characteristic *Senecio Pseudo-Arnica* (fig. 10), abounding on the strands of Bering Sea, thence southward to Japan and Vancouver, and about the Gulf of St. Lawrence, northward on the coast of Labrador and south very locally to the entrance of the Bay of Fundy.

The illustrations which I have thus far given serve to indicate the chief North American affinities of the flora of New England and the region about the Gulf of St. Lawrence; but these North American affinities are only half the story; for this complex region has in its flora large elements which are identical with or closely related to

floras in the remotest corners of the globe. The best known of these discontinuous floras is, of course, the case of temperate eastern America and temperate eastern Asia, which together share scores of genera and subgenera and even a unique family unknown in other parts of the world, while many more species and geographic varieties are confined to these two most remote regions. This famous group of plants, long ago pointed out by Asa Gray, may be illustrated by the tulip-tree, *Liriodendron Tulipifera* (fig. 11), with two living areas, one from New England to the Great Lakes and the Gulf of Mexico, the other (of var. *chinense*) in China. Very similar ranges are displayed, though often with greater development in Asia, by genera such as the monotypic *Symplocarpus* (fig. 12), by *Magnolia*, *Menispermum*, *Podophyllum*, *Caulophyllum*, *Panax*, *Phryma*, and numerous others. In fact, so frequent is this identity that we are now discovering upon close inspection that common Alleghenian plants, which have long been identified with continental European species, are in reality quite distinct from the European but inseparable from their eastern Asiatic representatives. Thus the common Alleghenian enchanter's nightshade, which for a century and a half has passed as the continental European *Circaea lutetiana*, proves to be not that species but to be identical with the plant of eastern Asia. The disrupted range of this species, *C. latifolia*, is essentially like that of *Symplocarpus foetidus*. Very recently other cases have come to attention. For instance, Butters, in studying certain widely diffused groups of ferns, discovered that in its essential character the common lady fern of eastern America which has generally been considered the European *Athyrium Filix-femina*, is really very different and constitutes a distinct east-American species, *A. angustum*, but that collections from China and Amur show fronds quite inseparable from the east-American plant. Again, in his studies of the variations of *Botrychium virginianum*, Butters found pronounced characters in the sporangia, which separate the European plant as var. *europaeum*, but that the typical *B. virginianum* of temperate eastern America reappears in China.

Other plants of much broader and almost general occurrence throughout temperate Eurasia are found in America only at the extreme eastern margin of the continent. Such a species is *Stellaria uliginosa* of wide Eurasian range, and found locally in springy spots from Newfoundland to Maryland. Of more restricted American range is *Potamogeton polygonifolius*, generally dispersed over Eurasia

and even in Madagascar and New Zealand, found on the Azores, and filling the ponds and streams of southeastern Newfoundland and of Sable Island, 100 miles off the Nova Scotia coast.

More restricted than the latter group is a series of species characteristic of the acid peats and silicious soils of Europe (but not Asia) and in America known only from southeastern Newfoundland or from Cape Breton. There are about 25 of these species, well represented by *Potentilla procumbens* of Europe, Madeira, the Azores, and peaty hillsides and borders of woods, in Newfoundland and Cape Breton. A similar distribution is shown by the beautiful pink-flowered *Pedicularis sylvatica*, in America found only in the peaty soils and "heaths" of southeastern Newfoundland where it is accompanied by *Sieglingia decumbens* (fig. 13), a monotypic grass which in the British Isles bears the highly appropriate name "Heath Grass."

Still more obviously the last relics of an ancient broad dispersal are plants now restricted to the extreme western margin of Europe or to the Azores and similarly found only at the extreme eastern margin of North America; such a genus as *Corema* (fig. 14) in the *Empetraceae*, with two known species, one found only in Portugal and adjacent Spain and the Azores, the other from New Jersey to the Gulf of St. Lawrence; or that most distinct of Saxifrages, *Saxifraga Geum* (fig. 15), known only from southwestern Ireland, the Pyrenees and southeastern Newfoundland.

One more European affinity may take our attention for a moment, the maritime plants restricted to northwestern Europe and the Gulf of St. Lawrence region. As illustrations three species may serve: *Atriplex maritima* of the sea-sands from the southern Baltic through the English Channel, and on the sands of eastern New Brunswick, Prince Edward Island and the Magdalen Islands; *Polygonum Raii* of the shores of the British Isles and the Channel, reappearing about the Gulf of St. Lawrence and on Sable Island; and another littoral *Polygonum*, *P. acadiense*, recently described from Cape Breton and subsequently found to occur as a hitherto undetected species in Europe, where, according to Professor Ostenfeld, it replaces *P. Raii* on the shores of the Baltic and in northern Norway.

These are by no means all the life-areas of the northern hemisphere, but they are sufficient, it will be agreed, to indicate that there are few regions of boreal and temperate North America and Eurasia which do not show identities with or close affinities to the complex flora of

the New England-Gulf of St. Lawrence district. But these striking relationships are not confined to the northern hemisphere. South America, Polynesia, Australia and even Africa all show conspicuous cases of identity or generic affinity. One of the widely dispersed genera of the southern hemisphere is *Schizaea*, a group of fern-like plants with 26 species, 25 of which are almost confined to the southern hemisphere (Australia, New Zealand, Polynesia, South America and South Africa), a few of them crossing the equator in the Tropics. No species is known in the Old World north of Madagascar, the Seychelles, India and the Philippines; *i. e.*, the group is absent from practically the whole continental area of Eurasia and Africa. Similarly in the western hemisphere it is wanting in North America north of tropical Mexico and Cuba, with the single exception of one of the most famous species of the northeastern coastal area. This species, *S. pusilla*, was described by Pursh from the Pine Barrens of New Jersey and almost simultaneously by LaPylaie from Newfoundland, LaPylaie making the discerning observation that the same species had been collected by Gaudichaud on the Falkland Islands. For three fifths of a century the Newfoundland record was held in suspicion, and it was believed that LaPylaie's specimens had really come from New Jersey. In 1879, however, the plant was found in Nova Scotia by Mrs. Britton, and later rediscovered in Newfoundland by Waghorne, and intermediate stations on Cape Breton have been brought to light by Nichols; and I can state from personal observation that the great development of this unique plant is in Newfoundland where, with a species of the coastal plain genus *Bartonia*, it often fills the exsiccated depressions in the tundra. The species is, then, an extreme northern relic of an ancient group now generally confined to the southern hemisphere. I have mentioned LaPylaie's conviction that an identical plant occurs on the Falkland Islands. This is *S. australis*, which certainly is so close to the northern *S. pusilla* that little violence would be done exact classification if they were treated as one.

Of very similar world-distribution is the family *Xyridaceae* but absent from Polynesia and more generally dispersed in Africa. North of Cuba and tropical Mexico the family is found only on the Atlantic slope from Texas to Newfoundland, with a couple of species in peaty habitats about the Great Lakes. The *Haemadoraceae* (fig. 18), likewise, belong primarily in the southern hemisphere, with 17 species in Australia, 11 at the Cape of Good Hope, and the remaining remnant

localized from northern Brazil to Vera Cruz and by way of the Antilles and the coastal plain extending to eastern Massachusetts.

These austral groups, *Schizaea*, the *Xyridaceae* and *Haemadorea-ceae*, are merely illustrative cases of a large series of families and genera, which in temperate North America are confined to a very restricted region of the Atlantic slope. Other genera, widely dispersed in the southern hemisphere and the tropics but essentially unknown in continental Eurasia, are more generally dispersed in North America. Here belongs the xerophytic genus *Pellaea* of southern and eastern Africa, the Cape Verde Islands, the Azores, India, Flores Island, Australia, Tasmania, New Zealand, various Pacific Islands, the Andes, and mountains of southeastern Brazil; and in North America widely dispersed from Costa Rica to British Columbia, Mackenzie and western New England. As notable as any species is the extremely xerophytic *P. densa*, a unique species, with a known occurrence in Costa Rica, arid mountains from California to southern British Columbia and Idaho, locally in the central Rocky Mountains, the Bruce Peninsula in Ontario, and arid mountain-walls of Megantic and Gaspé Cos., Quebec. Here, then, is a species of a widely dispersed austral genus highly developed in the Sierra Nevada and Cascade Mountains but locally abundant at remote points quite to the eastern margin of the continent. Another illustration inevitably suggested by *Pellaea densa* is that remarkable group of xerophytic ferns constituting a well-marked section or subgenus of *Polystichum*. I refer to *P. mohrioides* and its allies (fig. 17). There are four or five species of this alliance, all plants of the highest degree of localization. *P. mohrioides* and other austral species are known only from the Antarctic Prince Edward Islands, 1,200 miles southeast of the Cape of Good Hope, from the Falkland Islands, Tierra del Fuego, and Patagonia, and as the rarest of isolated species in the Andes. In North America we have two species so close to *P. mohrioides* that some authors have considered them inseparable: *P. Lemmoni*, a famous rare species of the mountains of California, Oregon and Washington; and *P. scopulinum* of similar range, though even rarer, and found with *Pellaea densa* on arid mountain-walls of Gaspé County, Quebec.

This Fuegian affinity is not confined, however, to the extreme xerophytes. It occasionally appears in pronounced hydrophytes. For instance, the plant of wet subsaline shores from the Mississippi Valley to the Pacific which has erroneously passed as *Rumex persicarioides* has been

recently demonstrated to be a unique American representative of the Eurasian *R. maritimus*, differing from the Old World plant in constant characters which led Philippi and Dusén to set it off as *R. maritimus*, var. *fueginus*. Outside its broad range in interior and western North America, var. *fueginus* is known on Tierra del Fuego and on the coast from Rhode Island to the Gulf of St. Lawrence, chiefly on the outer islands which persist as a remnant of the continental shelf: Block Island, Martha's Vineyard, Nantucket, Sable Island and the Magdalen Islands.

Three more illustrations, and I shall have finished this long catalogue. Certain genera, chiefly of the southern hemisphere, are noteworthy because of their restriction there to Australia or Australia and New Zealand and tropical South America and their occurrence north of tropical North America only on the Atlantic slope. Of such genera two examples may serve. *Psilocarya* (fig. 16) occurs in tropical Australia and tropical eastern South America and Cuba, and is represented in continental North America by two extremely local species. The most remarkable of these is *P. scirpoides*, as rare a sedge as we have in our flora, known only from wet sands and peats of southern Massachusetts and Rhode Island, and at similar unique stations near the head of Lake Michigan. As our second illustration may be taken the genus *Erechtites* (fig. 19), highly developed in Australia, New Zealand, eastern and northern South America, Central America, tropical Mexico and the Antilles, and represented in eastern North America by the widely dispersed fire-weed, *E. hieracifolia*. The only other species of temperate North America is a unique plant, *E. megalocarpha*, of the sea-strands of southern Cape Cod, there occurring on one of the most ancient of habitats, the strand of the Atlantic.

In fact the ever-shifting but ecologically uniform and never-changing sea-margin is largely inhabited by an extreme relic flora. This has already been pointed out in case of plants of Bering Sea or the North Pacific, occurring likewise on the strands of the Gulf of St. Lawrence, as well as by such plants as *Polygonum acadiense* on the seashores of Cape Breton and of the lands bordering the Baltic. This persistence on our coast of relics of an ancient wide dispersal in saline habitats is well shown by the remarkable *Junci thelassii*. This unique section of the genus has seven living species, all of saline and subsaline habitats and with a distribution "which indicates that they are remnants of an ancient group. *J. acutus* or one of its varieties occurs in

the Atlantic and Mediterranean regions of Europe and northern Africa, the coasts and steppes of southwestern Asia, the Atlantic Islands (Madeira, the Azores and Bermuda), Cape of Good Hope, the coast of California, southern Brazil, Uruguay, Argentina, Chile and the Islands of Juan Fernandez off the coast of Chile. *J. Cooperi* is known only from saline regions of California and Nevada; *J. Roemerianus* only on the coast from Virginia to Texas; *J. austerus* only from Chile; and *J. Kraussii* only from South Africa; while *J. maritimus* is widely but interruptedly dispersed: on the Atlantic and Mediterranean coasts of Europe, southwestern Asia and northeastern Africa, Cape of Good Hope, the Azores, Bermudas, Brazil, Australia, Tasmania and New Zealand, with its only station on the North American coast on Coney Island, New York." The seventh species occupies an area of only a few square rods in a marsh on the southern margin of Cape Cod and on account of its apparent antiquity has been called *J. pervetus*.

I have now closed my long enumeration of the world-floras to which the New England-Gulf of St. Lawrence flora shows strong affinities. If in the enumeration I have omitted any conspicuous areas it must be recognized that it is impossible in one hour to refer to every corner of the globe. It has often been asserted by our friends to the west of New England that the Autocrat was too ready to admit that "Boston State-house is the hub of the solar system"; but at least they cannot deny that Boston is nearer than other large American cities to the center of the Garden of Eden.

I am often urged by those whose interest in phytogeography does not descend to such minute details as actual species and varieties to "write something about the vegetation of New England. We have had enough about its flora; what we need is an account of the vegetation." To which I am forced to reply that, until we know the species and varieties which constitute the flora, it is premature to enter far into generalizations which depend for their value upon unquestionable premises. And that we are just beginning to know the flora of New England and the region about the Gulf of St. Lawrence should be sufficiently apparent when a summer's botanizing by a single pair of workers in the old states of Maine and Massachusetts results, as did the summer of 1916, in the positive extensions of known ranges of 725 species and the addition to the flora of one state or the other of 64 species, 23 of them new to New England and a full dozen quite new to science.

Only a very limited portion of Puritan New England and old French Canada, Acadia and Newfoundland is yet known to the botanist; and hundreds of unnamed alpine tablelands and cañons yet remain to yield a wealth of endemic and relic species. Only about ten of the hundreds of river-estuaries have been even casually explored and each of these has yielded isolated and often endemic colonies of plants. Our sand plains are just being tapped and there are still areas of thousands of square miles in the Gaspé Peninsula and Newfoundland where no man, either white or red, has yet set foot. But the most available source of discoveries for the future is in the little land-locked or kettle-hole ponds which fleck southern New England, Nova Scotia, the Magdalen Islands and Newfoundland like innumerable bits of mirror scattered over a lawn. There are literally thousands and thousands of these tiny ponds and pools without outlets. Many are on the maps but the majority of them have been thought unworthy either recognition on the government maps or the dignity of a name. Perhaps seventy-five out of the tens of thousands of these small ponds and pools have been visited by botanists and everywhere, whether in Rhode Island, southeastern Massachusetts or in the tundra of Newfoundland, the experience is the same: the number of remarkable species discovered in a given area seems limited only by the number of pools visited. I was recently asked by a famous expert on peat-bogs of the Central States what sedge it is which makes up the peat of southeastern Massachusetts. My answer, that the sedge would differ with the different ponds was hardly what he expected but, with due allowance for occasional repetitions and recombinations, the statement is quite true. One pool may be choked by *Scirpus Torreyi*; the next given over to *Eleocharis Robbinsii*; a few rods beyond another full of *Juncus militaris*; then another filled with *Scirpus subterminalis*, while the next is crowded with a rank growth of *Rhynchospora macrostachya*. Such is the everyday experience. But the most baffling feature of these numberless pools and pondholes, a condition discovered only two years ago, is the fact that the borders of many of them are inhabited by two entirely distinct floras. During autumns following a rainy summer the water-table is high and the shore of the pond is a wet peat-bog; during seasons with a long summer drouth the shore is a dry sand-beach. One illustration of this feature will serve. The most visited and best known of these ponds is Winter Pond in Middlesex County, Massachusetts, which for three fourths of a century

has been a never-ending source of surprises. For twelve years I have taken my classes there in October with the hope of showing them *Scirpus Hallii*, isolated by more than 1,000 miles from the nearest station in southern Georgia; *Echinodorus tenellus*, isolated by 260 miles from the next station to the south, in southern New Jersey; and *Eleocharis Engelmanni*, var. *detonsa* and *Ludvigia polycarpa* of prairie-sloughs of the Mississippi basin. But for many years, since 1908, Winter Pond was low and the shore a sandy beach, with the result that these plants have not flourished. In their stead have been found such xerophilous species as *Aristida gracilis*, *Crotalaria sagittalis* and *Cassia nictitans*. In 1916, however, the summer was extremely rainy and when, in October, I took my class to Winter Pond to see the *Crotalaria* and *Cassia*, we found the shore covered with wet peat, with a dense carpet of the long-lost *Scirpus Hallii*, the *Echinodorus*, *Eleocharis* and *Ludvigia* and practically no *Cassia* nor *Crotalaria* to be found. Similar experiences were noted on Cape Cod, and as a result we now understand that we cannot really know the floras of these thousands of pond-shores until they have all been intensively studied in both wet and dry years and throughout the season. When, therefore, the botanist who still retains a New England conscience is urged to "dash off something about the vegetation of New England," he naturally hesitates to write about what he knows he does not yet understand.

Throughout this presentation I have used the term phytogeography, not because that term as often used in America signifies an accurate knowledge of plant-distribution, but because it is a term which ought to stand for a scholarly and precise branch of our science. Unfortunately, many Americans who have styled themselves phytogeographers have not hesitated to stultify the subject by the publication of the point of view that, from the phytogeographer's standpoint, the exact identity of the plants is of little consequence. So long as any "phytogeographers" hold such views they must not expect to win the commendation of those who are striving for final truth. Imagine such sentiments expressed by Linnaeus, Wahlenberg, Alphonse de Candolle, Darwin, Hooker, or Gray! In the American rush to see ourselves in print and not to trouble about precision of detail we are too apt to forget the wise saying of Dr. Holmes: "Knowledge and timber shouldn't be used till they are seasoned." As I have elsewhere had occasion to say, "Much inaccurate and unscholarly publication has seriously injured taxonomy; the same tendency intensified has cheap-

ened ecology; and, unless we take the utmost pains to verify all compilations and to publish only what we have critically studied and digested, we shall soon cheapen and discredit phytogeography as well." Let us then set a high rather than an easy-going and off-hand standard, and phytogeography, which requires the most discriminating knowledge of exact identities as well as a broad outlook upon world-affinities and the power to draw logical deductions, will take in our country the dignified position of authority it has occupied in Europe.

It is frequently said with some suggestion of sarcasm that New England is the region where botanists still carry a vasculum and collect specimens. Yes, it certainly is! And from what I have today outlined in the merest framework of a sketch it is obvious that the New Englander and his Canadian and Newfoundland neighbors will botanize for generations to come before they fully unravel their complicated flora and the vast processes by which vascular plants of nearly all regions of the globe have reached their unique corner of the North American continent.

GRAY HERBARIUM,
HARVARD UNIVERSITY

EXPLANATION OF PLATES XII-XIV

PLATE XII

Range of 1. *Rosa nitida*; 2. *Ilex monticola*; 3. Genus *Bartonia*; 4. *Drosera filiformis*; 5. *Eleocharis interstincta*; 6. *Ludvigia polycarpa*; 7. *Potamogeton filiformis*, var. *Macounii*; 8. *Lonicera involucrata*; 9. *Dryas Drummondii*; 10. *Senecio Pseudo-Arnica*; 11. *Liriodendron Tulipifera* and var. *chinense*; 12. *Symplocarpus foetidus*.

PLATE XIII

Ranges of 13. *Sieglingia decumbens*; 14. Genus *Corema*, *C. alba* in outlined ellipses, *C. Conradii* in solid black. 15. *Saxifraga Geum*. 16. Genus *Psilocarya*, *P. nitens* in circles, *P. scirpoides* in squares, remaining species in solid black. 17. *Polystichum mohrioides* and allies, *P. scopulinum* in solid black squares, *P. Lemmoni* in circles, the remaining species in solid black dots and ellipses.

PLATE XIV

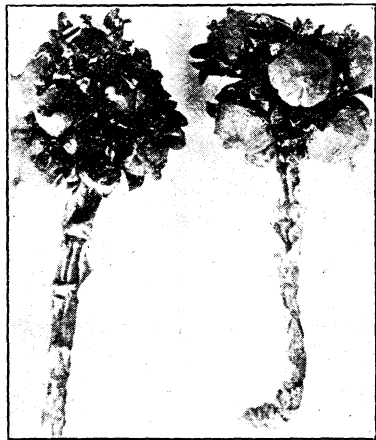
Ranges of 18. Family *Haemadoraceae*. 19. Genus *Erechtites*, *E. hieracifolia* in the outlined ellipse, *E. megalocarpa* in the small square, the remaining species in solid black.

CRYPTOPHILA PUDICA.

PLATE I.



No. 2



No. 3



No. 1

